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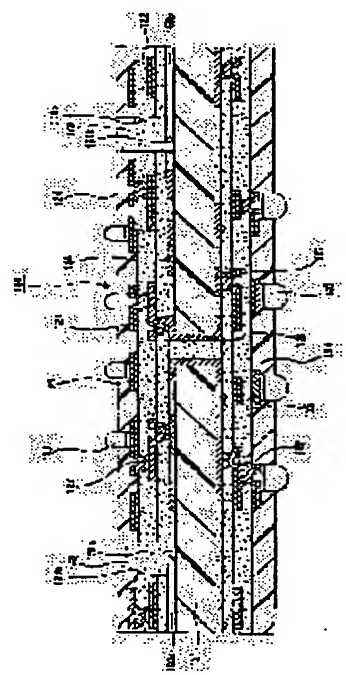
(54) RESIN COMPOSITION FOR OPTICAL WAVEGUIDE, OPTICAL WAVEGUIDE AND MULTI-LAYER PRINTED WIRING BOARD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a multi-layer printed wiring board forming an optical waveguide capable of transmitting both of an optical signal and an electric signal and effectively transmitting the optical signal without generating cracks or peeling even at the time of receiving heat history.
SOLUTION: In the multi-layer printed wiring board forming the optical waveguide on its surface or inside, the optical waveguide contains grains.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The resin constituent for optical waveguides characterized by containing the particle.
[Claim 2] Said resin constituent for optical waveguides is acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane one, cyclohexadiene system resin, norbornene system resin, polyolefine, and a resin constituent for optical waveguides according to claim 1 of the polystyrene that contains a kind at least as a resinous principle.
[Claim 3] Said particle is a kind or the resin constituent for optical waveguides according to claim 1 or 2 which is two or more sorts of mixture of a resin particle, an inorganic particle, and the metal particles at least.
[Claim 4] Said resin particle is a kind or the resin constituent for optical waveguides according to claim 3 which consists of two or more sorts of mixture of the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, thermosetting resin, and thermoplastics, and the resin complex of a photopolymer and thermoplastics at least.
[Claim 5] Said inorganic particle is an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, and a kind or the resin constituent for optical waveguides according to claim 3 or 4 which consists of two or more sorts of mixture of the titanium compounds at least.
[Claim 6] Said metal particles are the resin constituents for optical waveguides given in any 1 of Au, Ag, Cu, Pd, nickel, and the Pt(s) of claims 3-5 which consist of a kind or two sorts or more of mixture at least.
[Claim 7] The loadings of said particle are a resin constituent for optical waveguides claim 1 which is 10 - 80 % of the weight - given [any 1] in six.
[Claim 8] The configuration of said particle is a resin constituent for optical waveguides claim 1 which are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside - given [any 1] in seven.
[Claim 9] The resin constituent for optical waveguides claim 1 with a particle size of said particle shorter than the wavelength of propagation light - given [any 1] in eight.
[Claim 10] Optical waveguide characterized by containing the particle.
[Claim 11] Said optical waveguide is acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane one, cyclohexadiene system resin, norbornene system resin, polyolefine, and optical waveguide according to claim 10 that contains a kind of hardened material of the polystyrene at least as a resinous principle.
[Claim 12] Said particle is a kind or the optical waveguide according to claim 10 or 11 which is two or more sorts of mixture of a resin particle, an inorganic particle, and the metal particles at least.
[Claim 13] Said resin particle is optical waveguide according to claim 12 of the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, thermosetting resin, and thermoplastics, and the resin complex of a photopolymer and thermoplastics which consists of a kind or two sorts or more of mixture at least.
[Claim 14] Said inorganic particle is optical waveguide according to claim 12 or 13 of an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, and the titanium compounds which consists of a kind or two sorts or more of mixture at least.

[Claim 15] Said metal particles are optical waveguide given in any 1 of claims 12-14 of Au, Ag, Cu, Pd, nickel, and the Pt(s) which consist of a kind or two sorts or more of mixture at least.
[Claim 16] The loadings of said particle are optical waveguide claim 10 which is 10 - 80 % of the weight - given [any 1] in 15.
[Claim 17] The configuration of said particle is optical waveguide claim 10 which are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside - given [any 1] in 16.
[Claim 18] Optical waveguide claim 10 with a particle size of said particle shorter than the wavelength of propagation light - given [any 1] in 17.
[Claim 19] The particle size of said particle is optical waveguide claim 10 which is 1/2 or less [of the die length of the side of the one where the cross-section configuration of a direction perpendicular to the travelling direction of the lightwave signal of said optical waveguide is a rectangle, and said rectangle is longer] - given [any 1] in 17.
[Claim 20] It is the multilayer printed wiring board characterized by being the multilayer printed wiring board with which optical waveguide was formed in the front face or interior, and said optical waveguide containing the particle.
[Claim 21] Said optical waveguide is a multilayer printed wiring board according to claim 20 of acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane one, cyclohexadiene system resin, norbornene system resin, polyolefine, and the resin that consists of polystyrene which contains a kind at least as a resinous principle.
[Claim 22] Said particle is a kind or the multilayer printed wiring board according to claim 20 or 21 which is two or more sorts of mixture of a resin particle, an inorganic particle, and the metal particles at least.
[Claim 23] Said resin particle is a multilayer printed wiring board according to claim 22 of the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, thermosetting resin, and thermoplastics, and the resin complex of a photopolymer and thermoplastics which consists of a kind or two sorts or more of mixture at least.
[Claim 24] Said inorganic particle is a multilayer printed wiring board according to claim 22 or 23 of an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, and the titanium compounds which consists of a kind or two sorts or more of mixture at least.
[Claim 25] Said metal particles are multilayer printed wiring boards given in any 1 of claims 22-24 of Au, Ag, Cu, Pd, nickel, and the Pt(s) which consist of a kind or two sorts or more of mixture at least.
[Claim 26] The loadings of said particle are a multilayer printed wiring board claim 20 which is 10 - 80 % of the weight - given [any 1] in 25.
[Claim 27] The configuration of said particle is a multilayer printed wiring board claim 20 which are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside - given [any 1] in 26.
[Claim 28] A multilayer printed wiring board claim 20 with a particle size of said particle shorter than the wavelength of propagation light - given [any 1] in 27.
[Claim 29] The particle size of said particle is a multilayer printed wiring board claim 20 which is 1/2 or less [of the die length of the side of the one where the cross-section configuration of a direction perpendicular to the travelling direction of the lightwave signal of said optical waveguide is a rectangle, and said rectangle is longer] - given [any 1] in 27.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the resin constituent for optical waveguides, optical waveguide, and a multilayer printed wiring board.
[0002] In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed. In the communication system using the optical fiber which has the descriptions, such as ** low loss, ** high bandwidth, ** narrow diameter and a light weight, no ** guiding, and ** saving resources, and has this description, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced substantially, construction and maintenance become easy, and an optical fiber can attain economization of communication system, and high-reliability-ization.
[0003] Moreover, since an optical fiber can multiplex simultaneously the light of the wavelength from which not only the light of one wavelength but many differ with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004] Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed. Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., in order for IC which performs information (signal) processing in a terminal equipment to operate with an electrical signal, it is necessary to attach the equipment (henceforth light/electric transducer) which changes the lightwave signal and electrical signal of optical -> electric transducer, electric -> phototransducer, etc. into a terminal equipment. So, in the conventional terminal equipment, the optical waveguide which transmits the lightwave signal sent from the outside through an optical fiber etc. to light/electric transducer, for example, or transmits the lightwave signal sent from light/electric transducer to an optical fiber etc., and the multilayer printed wiring board which transmits an electrical signal through a solder bump were mounted independently, and a signal transmission and signal processing were performed.
[0005] Since optical waveguide and a multilayer printed wiring board were independently mounted in such a conventional terminal equipment, it was difficult for the whole equipment to become large and to achieve the miniaturization of a terminal equipment. Then, this invention persons proposed previously the multilayer printed wiring board with which optical waveguide was formed in the interior and front face as a multilayer printed wiring board which can be contributed to the miniaturization of a terminal equipment.
[0006]
[Problem(s) to be Solved by the Invention] Moreover, in the multilayer printed wiring board which contained such optical waveguide, well-known optical waveguide was conventionally used as optical waveguide. Since optical waveguide was formed in the interior, although the multilayer printed wiring board of such a configuration was excellent in the point of achieving the miniaturization of a terminal equipment, the transmission loss at the time of lightwave signal transmission might have become large.
[0007] In the case of for example, organic system optical waveguide, on the base material with which reinforcing materials, such as a ceramic, glass, and glass epoxy, consist of hard material, such as resin by which impregnation was carried out, the spin coater etc. was used for the conventional optical waveguide, it carried out spreading membrane formation of the liquefied polymer, and formed it by performing hardening processing after that. Since the coefficients of thermal expansion of the liquefied polymer, the above-mentioned base material, etc. which are used for formation of optical waveguide differed when forming optical waveguide by such approach, when hardening processing etc. was heat-treated, a crack may occur in optical waveguide with a large

coefficient of thermal expansion (film which consists of a liquefied polymer), or exfoliation may occur between optical waveguide and a base material, and generating of this crack and exfoliation might cause transmission loss.

[0008] Moreover, although it will expand when optical waveguide heat-treats as mentioned above Under the present circumstances, since the expansion coefficient (it considers as the coefficient of thermal expansion of the X-axis / Y shaft orientations hereafter) of the direction of a field in contact with the substrate of optical waveguide etc. differs from the expansion coefficient (it considers as the expansion coefficient of Z shaft orientations hereafter) of the direction which intersects perpendicularly with a substrate etc., The transmission loss which the balance in the TM0 mode at the time of lightwave signal transmission and the TE0 mode will collapse, and originated in this by thermal expansion might occur in optical waveguide.
[0009] Furthermore, in manufacture of a multilayer printed wiring board, after collapse of balance with the TM0 mode and the TE0 mode by such thermal expansion formed optical waveguide on the substrate or the resin insulating layer between layers, it might be generated also by heat treatment at the time of forming other members (a solder resist layer, solder bump, etc.).
[Means for Solving the Problem] Then, in order to have solved the above-mentioned problem, by making the resin constituent for optical waveguides contain a particle, this invention person etc. hit on an idea for what is necessary to be just to adjust the coefficient of thermal expansion of optical waveguide, a substrate, etc., and completed this invention shown below.
[0010] That is, the resin constituent for optical waveguides of this invention is characterized by containing the particle. The resin constituent for optical waveguides of this invention has the desirable thing of acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane ones, cyclohexadiene system resin, norbornene system resin, polyolefine, and the polystyrene included for a kind at least as a resinous principle.
[0011] Moreover, as for the above-mentioned particle, in the above-mentioned resin constituent for optical waveguides, it is desirable that they are a kind or two sorts or more of mixture at least of a resin particle, an inorganic particle, and the metal particles. As for the above-mentioned resin particle, it is desirable that it is the thing of the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, thermosetting resin, and thermoplastics, and the resin complex of a photopolymer and thermoplastics which consists of a kind or two sorts or more of mixture at least.
[0012] As for the above-mentioned inorganic particle, it is desirable that it is the thing of an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, and the titanium compounds which consists of a kind or two sorts or more of mixture at least. As for the above-mentioned metal particles, it is desirable that it is the thing of Au, Ag, Cu, Pd, nickel, and the Pt(s) which consists of a kind or two sorts or more of mixture at least.
[0013] As for the loadings of the particle contained in this resin constituent for optical waveguides, in the above-mentioned resin constituent for optical waveguides, it is desirable that it is 10 - 80 % of the weight. Moreover, as for the configuration of the above-mentioned particle, it is desirable that they are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside. As for the particle size of the above-mentioned particle, in the above-mentioned resin constituent for optical waveguides, it is desirable that it is shorter than the wavelength of propagation light.
[0014] Optical waveguide of this invention is characterized by containing the particle. As for the above-mentioned optical waveguide, it is desirable as a resinous principle to include a kind of hardened material of acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane one, cyclohexadiene system resin, norbornene system resin, polyolefine, and the polystyrene at least. Moreover, as for the above-mentioned particle, in the above-mentioned optical waveguide, it is desirable that they are a kind or two sorts or more of mixture at least of a resin particle, an inorganic particle, and the metal particles.
[0015] As for the above-mentioned resin particle, it is desirable that it is the thing of the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, thermosetting resin, and thermoplastics, and the resin complex of a photopolymer and thermoplastics which consists of a kind or two sorts or more of mixture at least. As for the above-mentioned inorganic particle, it is desirable that it is the thing of an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, and the titanium compounds which consists of a kind or two sorts or more of mixture at least. As for the above-mentioned metal particles, it is desirable that it is the thing of Au, Ag, Cu, Pd, nickel, and the Pt(s) which consists of a kind or two sorts or more of mixture at least.
[0016] As for the loadings of the particle contained in this optical waveguide, in the above-mentioned optical

waveguide, it is desirable that it is 10 - 80 % of the weight. Moreover, as for the configuration of the above-mentioned particle, it is desirable that they are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside. As for the particle size of the above-mentioned particle, in the above-mentioned optical waveguide, it is desirable that it is shorter than the wavelength of propagation light.
[0017] Moreover, in the optical waveguide of this invention, the cross-section configuration of a direction vertical to the travelling direction of the lightwave signal of this optical waveguide is a rectangle, and it is desirable for the particle size of the above-mentioned particle to be also 1/2 or less [of the die length of the side with the above-mentioned longer rectangle].
[0018] The multilayer printed wiring board of this invention is a multilayer printed wiring board with which optical waveguide was formed in the front face or interior, and the above-mentioned optical waveguide is characterized by containing the particle.
[0019] In the above-mentioned multilayer printed wiring board, the above-mentioned optical waveguide has the desirable thing of acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane ones, cyclohexadiene system resin, norbornene system resin, polyolefine, and the polystyrene included for a kind at least as a resinous principle.
[0020] Moreover, as for the particle which the above-mentioned optical waveguide contains, in the above-mentioned multilayer printed wiring board, it is desirable that they are a kind or two sorts or more of mixture at least of a resin particle, an inorganic particle, and the metal particles.
[0021] As for the above-mentioned resin particle, it is desirable that it is the thing of the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, thermosetting resin, and thermoplastics, and the resin complex of a photopolymer and thermoplastics which consists of a kind or two sorts or more of mixture at least.
[0022] The above-mentioned inorganic particle has the desirable thing of an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, and the titanium compounds which consists of a kind or two sorts or more of mixture at least. The above-mentioned metal particles have the desirable thing of Au, Ag, Cu, Pd, nickel, and the Pt(s) which consists of a kind or two sorts or more of mixture at least.
[0023] Moreover, as for the loadings of the above-mentioned particle, in the above-mentioned multilayer printed wiring board, it is desirable that it is 10 - 80 % of the weight. Moreover, as for the configuration of the above-mentioned particle, it is desirable that they are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside.
[0024] Moreover, as for the particle size of the above-mentioned particle, in the multilayer printed wiring board of this invention, it is desirable that it is shorter than the wavelength of propagation light. Moreover, in the above-mentioned multilayer printed wiring board, the cross-section configuration of a direction vertical to the travelling direction of the lightwave signal of the above-mentioned optical waveguide is a rectangle, and it is desirable for the particle size of the above-mentioned particle to be also 1/2 or less [of the die length of the side with the above-mentioned longer rectangle].
[Embodiment of the Invention] First, the resin constituent for optical waveguides of this invention is explained. The resin constituent for optical waveguides of this invention is characterized by containing a particle.
[0025] Since the resin constituent for optical waveguides of this invention contains the particle, when forming optical waveguide on the base material which consists of hard material using this resin constituent for optical waveguides Adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, the above-mentioned base material, etc. The optical waveguide which consists of the above-mentioned resin constituent for optical waveguides which hardly generated the crack and exfoliation resulting from the difference of a coefficient of thermal expansion, and was formed on the base material etc. In the carrier beam case, since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses the heat history. Therefore, the optical waveguide which can control the transmission loss of the lightwave signal resulting from these, and consists of a resin constituent for optical waveguides of this invention can transmit a lightwave signal good.
[0026] Moreover, as for the particle size of the particle which the above-mentioned resin constituent for optical waveguides contains, it is desirable that it is shorter than the wavelength of propagation light, and transmission of a lightwave signal of inhibition fear decreases more by existence of a particle in this case. In this description in addition, with "the particle size of a particle is shorter than the wavelength of propagation light" It is what does not specify the absolute value of particle size and specifies the size relation of the wavelength of a

lightwave signal and the particle size of a particle which are used at the time of lightwave signal transmission. For example, at the optical waveguide which communicates with a lightwave signal with a wavelength of 1.55 micrometers, the particle size of the particle to contain is less than 1.55 micrometers, and the optical waveguide which communicates with a lightwave signal with a wavelength of 0.85 micrometers means that the particle size of the particle to contain is less than 0.85 micrometers.
[0027] The resin constituent for optical waveguides of this invention contains the particle, and a resin particle, an inorganic particle, metal particles, etc. are mentioned as the example, for example. What consists of resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, complex of a photopolymer and thermoplastics, etc. as the above-mentioned resin particle, for example is mentioned.
[0028] Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); what consists of photopolymers, such as acrylic resin, etc. is mentioned. Moreover, what consists of resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used. Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.
[0029] Moreover, as the above-mentioned inorganic particle, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silicon dioxide (silica), and a zeolite, and a titanium dioxide (titania), etc. is mentioned, for example. Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.
[0030] As the above-mentioned metal particles, what consists of gold, silver, copper, palladium, nickel, platinum, iron, zinc, lead, aluminum, magnesium, calcium, etc. is mentioned, for example. These resin particles, an inorganic particle, and metal particles may be used independently, and may be used with two or more sorts of mixture. When using two or more sorts of mixture, as the above-mentioned particle specifically After melting two or more sorts of particles and mixing, may use it, may use it, coating other particles around one kind of particle, and The particle of the structure with which other particles went into the interior of the crystal structure of one kind of particle or the molecular structure may be used, and the particle of the structure with which the mutual crystal structure and/or the mutual molecular structure of two kinds of particles became entangled may be used.
[0031] Moreover, although especially the configuration of the above-mentioned particle is not limited, it is desirable that they are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside, and the shape of a globular shape or an ellipse ball is more desirable in these. Since there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, when optical waveguide is formed using the resin constituent for optical waveguides, it is because it is harder coming to generate a crack in this optical waveguide.
[0032] Although it is desirable that it is shorter than the wavelength of ****** to propagation light as for the particle size of the particle contained in the resin constituent for optical waveguides of this invention when it originates in existence of this particle and transmission of a lightwave signal is hard to be checked, it is not necessarily limited to this, and the particle size of the particle contained in the above-mentioned resin constituent for optical waveguides has desirable about 1-50 micrometers, and its about 1-20 micrometers are usually more desirable. When it is economically disadvantageous in order that cost may cost dearly, if particle size uses a less than 1-micrometer particle, and the particle to which particle size exceeds 50 micrometers is used, the viscosity control of the resin constituent for optical waveguides may become difficult.
[0033] In addition, in this description, the particle size of a particle means the average die length of the longest part of a particle. Moreover, the above-mentioned resin constituent for optical waveguides may contain the particle of two or more kinds of different particle size.
[0034] As for the loadings of the particle which the above-mentioned resin constituent for optical waveguides contains, it is desirable in optical waveguide that it is 10 - 80 % of the weight, and it is more desirable to it that it is 20 - 70 % of the weight. It is because transmission of a lightwave signal may be checked in the optical waveguide which consists of the above-mentioned resin constituent for optical waveguides when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight. In addition, it is meaningful in the

loadings of the particle contained in the optical waveguide produced using the optical waveguide resin constituent of this invention being 10 - 80 % of the weight with "the loadings of a particle are 10 - 80 % of the weight in optical waveguide."

[0035] The above-mentioned resin constituent for optical waveguides contains the resinous principle in addition to the above-mentioned particle, and acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane one, cyclohexadiene system resin, norbornene system resin, polyolefine, polystyrene, etc. are mentioned as this resinous principle, for example. These may be used independently and may be used together two or more sorts.

[0036] Moreover, the above-mentioned resin constituent for optical waveguides may contain the curing agent, the reaction stabilizer, the solvent, etc. if needed in addition to the above-mentioned particle or the resinous principle. Such a resin constituent for optical waveguides of this invention can be suitably used, in case the optical waveguide and the multilayer printed wiring board of this invention which are mentioned later are produced.

[0037] Next, the optical waveguide of this invention is explained. Optical waveguide of this invention is characterized by containing the particle.

[0038] Since the optical waveguide of this invention contains the particle, when being formed on the base material which consists of hard material The optical waveguide which could aim at adjustment of a coefficient of thermal expansion between optical waveguide, the above-mentioned base material, etc., and hardly generated the crack and exfoliation resulting from the difference of a coefficient of thermal expansion, and was formed on the base material etc. In the carrier beam case, since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses the heat history. Therefore, the transmission loss of the lightwave signal resulting from these can be controlled, and a lightwave signal can be transmitted good in the optical waveguide of this invention.

[0039] As for the above-mentioned optical waveguide, it is desirable as a resinous principle to include a kind of hardened material of acrylic resin, polyimide resin, an epoxy resin, UV hardenability resin, silicone resin, methacrylate resin, the resin that consists of benz-cyclo-butene, a fluororesin, polyurethane resin, polycarbonate resin, tricyclodecane one, cyclohexadiene system resin, norbornene system resin, polyolefine, and the polystyrene at least.

[0040] The above-mentioned optical waveguide contains the particle and, as for the above-mentioned particle, it is desirable that they are a kind or two sorts or more of mixture at least of a resin particle, an inorganic particle, and the metal particles. Moreover, as an example of the above-mentioned resin particle, the above-mentioned inorganic particle, and the above-mentioned metal particles, what is contained in the resin constituent for optical waveguides of this invention, the same thing, etc. are mentioned, for example.

[0041] Moreover, as for the loadings of the particle contained in the above-mentioned optical waveguide, it is desirable that it is 10 - 80 % of the weight, and, as for the configuration of the above-mentioned particle, it is desirable that they are a globular shape, an ellipse globular shape, a letter of crushing, and the configuration of one of polyhedron-like inside.

[0042] Moreover, as for the particle size of the particle contained in the above-mentioned optical waveguide, it is desirable that it is shorter than the wavelength of propagation light. It is because a possibility that it may originate in existence of a particle and transmission of a lightwave signal may be checked decreases more when particle size is shorter than the wavelength of propagation light.

[0043] Moreover, when the cross-section configuration of a direction vertical to the travelling direction of the lightwave signal of this optical waveguide is a rectangle, as for the particle size of the particle contained in the above-mentioned optical waveguide, it is desirable that it is 1/2 or less [of the die length of the side with the above-mentioned longer rectangle]. Also in the optical waveguide which the particle of such particle diameter contains, it is because a possibility that it may originate in existence of a particle and transmission of a lightwave signal may be checked decreases more.

[0044] Moreover, as for the optical waveguide of this invention, it is desirable to be stuck from the point that the effectiveness mentioned above is enjoyable, on the base material which consists of hard material. Moreover, it may be formed as an optical waveguide film on the sheet which can exfoliate. When the above-mentioned optical waveguide is stuck on the above-mentioned base material etc., it may be stuck on the substrate which consists of a substrate top which consists of silicon, or a ceramic, and the printed wired board may be stuck, and, specifically, optical waveguide may be stuck on the location (for example, this crevice) of requests, such as a resin plate which has a crevice on a front face, a metal plate, a ceramic plate, and a printed wired board. Furthermore, it may be mechanically fixed on the resin plate, the metal plate, the ceramic plate, etc. Thus, as for

the optical waveguide of this invention, it is desirable to be stuck on the front face of resin, a metal, the base material that consists of a ceramic, or a film, a base material, this crevice of a film where the crevice was formed in the part, etc.
[0045] As a resin plate which sticks the above-mentioned optical waveguide, a certain thing etc. is mentioned from thermoplastics, such as an epoxy resin, acrylic resin, methacrylic resin, silicone resin, and polycarbonate resin, thermosetting resin, or ultraviolet curing mold resin, for example. Moreover, as the above-mentioned metal plate, what consists of aluminum, brass, SUS, etc. is mentioned, for example. Moreover, in order to fix the above-mentioned optical waveguide mechanically, a spring, the screw stop of a fixed plate, etc. can be used.
[0046] Although what was fabricated as optical waveguide may be beforehand stuck when optical waveguide is stuck on the above-mentioned base material etc., it is good also as structure where optical waveguide was stuck on the base material etc. on the above-mentioned base material etc. by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order.
[0047] Moreover, optical waveguide of this invention is made [forming using the resin constituent for optical waveguides of this invention mentioned above, or].
[0048] Next, how to produce the optical waveguide of this invention is explained briefly. Formation of the above-mentioned optical waveguide can use for example, a selective polymerization method, the method of using reactive ion etching and photolithography, the direct exposing method, the approach using injection molding, the photograph breeching method, the approach that combined these.
[0049] Spreading membrane formation of the resin constituent for optical waveguides used as the undershirt clad section is specifically, for example, first, carried out on a base material etc. using a spin coater etc., heat hardening of this is carried out, after that, spreading membrane formation of the resin constituent for optical waveguides which serves as a core layer on the undershirt clad section is carried out, and heat hardening of this is carried out. Next, a resist is applied on the surface of a core layer, a resist pattern is formed with photolithography, and patterning is carried out to the configuration of the core section by RIE (reactive ion etching), an exposure development, etc. Furthermore, optical waveguide can be formed by carrying out spreading membrane formation of the resin constituent for optical waveguides used as the exaggerated clad section, and carrying out heat hardening of this on the undershirt clad section (a core section top being included), etc. In addition, an approach, printing, etc. which use a curtain coating machine and a roll coater may perform spreading membrane formation of a resin constituent. In addition, the presentation of the resin constituent for optical waveguides is beforehand adjusted here so that it may become that in which the core section and the clad section (undershirt clad section, exaggerated clad section) of the optical waveguide to produce have a desired refractive index, respectively.
[0050] Here, spreading of the resin constituent for optical waveguides may be performed at once, respectively, and you may carry out by dividing into multiple times. In addition, which is chosen should just choose suitably in consideration of the thickness of the clad section and the core section etc. Moreover, a non-hardened resin constituent may be replaced with the approach of carrying out spreading membrane formation, and the approach of sticking the film which consists of a resin constituent for optical waveguides formed beforehand may be used.
[0051] As the above-mentioned base material, for example A ceramic, AlN, a mullite, a zirconia, Metallic materials, such as inorganic materials, such as SiC, an alumina, silicon, and glass, copper, iron, and nickel, Thermosetting resin, thermoplastics, a photopolymer, the resin that acrylic-ized some thermosetting resin, The resin complex of thermosetting resin and thermoplastics, the resin complex of a photopolymer and thermoplastics, Processing to which what the reinforcing materials used for a printed wired board etc. become from resin ingredients, such as resin by which impregnation was carried out, etc. and the ingredient which combined these is mentioned according to smut processing or a coating agent in the front face of the above-mentioned base material again may be performed.
[0052] Optical waveguide what was mechanically fixed to the location (for example, this crevice) of the request on base materials, such as a resin plate which has a crevice on a front face, (optical waveguide substrate) moreover, production For example, film-like optical waveguide can be imprinted on base materials, such as a resin plate which forms optical waveguide in the shape of a film, and formed the crevice by ZAKURI processing etc. beforehand, and it can carry out by carrying out the screw stop of this optical waveguide on the fixed plate made from aluminum etc. after that. Thus, the produced optical waveguide substrate can be used as a bag plane which makes connection between a board and a board.
[0053] Next, the multilayer printed wiring board of this invention is explained. The multilayer printed wiring board of this invention is a multilayer printed wiring board with which optical waveguide was formed in the front face or interior, and the above-mentioned optical waveguide is characterized by containing the particle.
[0054] Since optical waveguide is formed, the multilayer printed wiring board of this invention can be contributed to the miniaturization of the terminal equipment for optical communication by being able to transmit both a

lightwave signal and an electrical signal, and forming optical waveguide in the multilayer printed wiring board.
[0055] Moreover, the optical waveguide of the multilayer printed wiring board of this invention Since the particle is contained, even if it can aim at adjustment of a coefficient of thermal expansion between this optical waveguide, and a substrate and the resin insulating layer between layers, and it hardly generates the crack and exfoliation resulting from the difference of a coefficient of thermal expansion and the above-mentioned optical waveguide receives the heat history Since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses. Therefore, the transmission loss of the lightwave signal resulting from these can be controlled, and a lightwave signal can be transmitted good in the multilayer printed wiring board of this invention.
[0056] As for the particle size of the particle contained in the optical waveguide formed in the above-mentioned multilayer printed wiring board, it is desirable that it is shorter than the wavelength of propagation light. It is because a possibility that it may originate in existence of a particle and transmission of a lightwave signal may be checked decreases more when particle size is shorter than the wavelength of propagation light.
[0057] Moreover, when the cross-section configuration of a direction vertical to the travelling direction of the lightwave signal of this optical waveguide is a rectangle, as for the particle size of the particle contained in the optical waveguide formed in the above-mentioned multilayer printed wiring board, it is desirable that it is 1/2 or less [of the die length of the side with the above-mentioned longer rectangle]. Also in the optical waveguide which the particle of such particle diameter contains, it is because a possibility that it may originate in existence of a particle and transmission of a lightwave signal may be checked decreases more.
[0058] As for the above-mentioned multilayer printed wiring board, optical waveguide is formed in the front face or interior. Therefore, a lightwave signal can be transmitted through the above-mentioned optical waveguide. Moreover, the particle contains in the above-mentioned optical waveguide, and such optical waveguide can be formed in it using the resin constituent for optical waveguides of this invention.
[0059] Moreover, since the formation is easy, it is a sheet-like and a rectangular thing has the cross-section configuration of a direction vertical to the travelling direction of the lightwave signal still more desirable [the shape of a sheet is desirable, and] although especially the configuration of the above-mentioned optical waveguide is not limited. Moreover, although what is necessary is not to limit especially the magnitude of the above-mentioned optical waveguide, but just to choose suitably according to the design of a multilayer printed wiring board etc., when this optical waveguide is the optical waveguide (henceforth the optical waveguide formed by the build up) by which laminating formation of the undershirt clad section, the core section, and the exaggerated clad section was carried out in this order, for example, the thickness and width of face of the above-mentioned optical waveguide have desirable 1-150 micrometers, and its 1-100 micrometers are more desirable. the conductor which constitutes a multilayer printed wiring board if the above-mentioned thickness and width of face are not sometimes easy for the formation in less than 1 micrometer and the above-mentioned thickness and width of face exceed 100 micrometers on the other hand -- it is because it may become the cause which checks the degree of freedom of designs, such as a circuit.
[0060] Moreover, it is desirable for thickness and width of face to be 5-25 micrometers, when the above-mentioned optical waveguide is the optical waveguide for single modes, and when the above-mentioned optical waveguide is the optical waveguide for multimodes, it is desirable for thickness and width of face to be 10-75 micrometers. In addition, the configuration of optical waveguide is a sheet-like, when the cross-section configuration of a direction vertical to the travelling direction of the lightwave signal is a rectangular thing, the side of one is thickness between two sides in this rectangle which are not parallel mutually, and other sides of the thickness of the above-mentioned optical waveguide and width of face are width of face.
[0061] Moreover, when the above-mentioned optical waveguide is produced by metal mold shaping and injection molding, the magnitude is larger than the optical waveguide formed by the above-mentioned build up, for example, the thickness and width of face are usually 50 micrometers - about 1mm.
[0062] In the above-mentioned multilayer printed wiring board, it is desirable as optical waveguide to form the optical waveguide for light-receiving and the optical waveguide for luminescence. In addition, the above-mentioned optical waveguide for light-receiving means the optical waveguide for transmitting the lightwave signal sent from the outside through an optical fiber etc. to a photo detector, and the above-mentioned optical waveguide for luminescence means the optical waveguide for transmitting the lightwave signal sent from the light emitting device to an optical fiber etc. It is desirable for the above-mentioned optical waveguide for light-receiving and the above-mentioned optical waveguide for luminescence to be what consists of the same ingredient. It is because adjustment of a coefficient of thermal expansion etc. is easy for a scale or the formation to like.
[0063] It is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide. By

forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle. Formation of the above-mentioned optical-path conversion mirror can be performed by cutting the end of optical waveguide so that it may mention later.

[0064] Moreover, in the above-mentioned multilayer printed wiring board, since optical waveguide is formed in the front face or interior, it is desirable to form opening for optical paths for transmitting a lightwave signal between this optical waveguide and external optical elements (a photo detector, a light emitting device, optical fiber, etc.) if needed. both sides of the substrate with which optical waveguide was specifically formed in a part of the front face for the multilayer printed wiring board of this invention — a conductor — when a circuit and the resin insulating layer between layers are the multilayer printed wiring boards by which laminating formation was carried out, it is desirable to form in one side of a substrate opening for optical paths which penetrates the resin insulating layer between layers by which laminating formation was carried out. Moreover, when the solder resist layer is formed in the outermost layer of drum of a multilayer printed wiring board so that it may mention later, it is desirable to form opening for optical paths which penetrates a solder resist layer and the resin insulating layer between layers and which was open for free passage.

[0065] Moreover, the inside of the above-mentioned opening for optical paths may be filled up with the resin which does not check transmission of a lightwave signal, for example, the resin used for the above-mentioned optical waveguide, the same resin, etc. While being able to protect the optical waveguide formed on the substrate by filling up the inside of opening for optical paths with resin, it is because it can prevent that dust, a foreign matter, etc. enter into this opening for optical paths, and transmission of a lightwave signal is checked by this. Moreover, when filling up the inside of the above-mentioned opening for optical paths with resin, the particle may contain to this resin. As an example of the particle contained here, what is contained in the resin constituent for optical waveguides of this invention, the same thing, etc. are mentioned, for example.

[0066] moreover, the above-mentioned multilayer printed wiring board — a substrate top — a conductor — the conductor which sandwiched this resin insulating layer between layers when laminating formation of a circuit and the resin insulating layer between layers was carried out — it is desirable between circuits for the Bahia hall to connect. a conductor — connecting circuits in the Bahia hall — a conductor — while being able to wire a circuit by high density — a conductor — the degree of freedom of a design of a circuit improves. moreover, the above — a conductor — as it is in explanation of the manufacture approach of the multilayer printed wiring board mentioned later, as for a circuit, being formed by the additive process is desirable. an additive process — the spacing — the conductor of detailed wiring of 50 micrometers or less — it is because it is suitable for forming a circuit. In addition, the above-mentioned additive process may be a fully-additive process, and may be a semiadditive process. the above — a conductor — the circuit may be formed by the subtractive process.

[0067] Moreover, in the above-mentioned multilayer printed wiring board, a solder resist layer is formed in an outermost layer of drum, and further, opening for solder bump formation is formed in this solder resist layer if needed, and you may be. It is because a solder bump can be formed, or PGA (Pin Grid Array) and BGA (Ball Grid Array) can be arranged and a multilayer printed wiring board, an external substrate, etc. can be electrically connected by this, when opening for solder bump formation is formed in a solder resist layer.

[0068] Moreover, in the multilayer printed wiring board of this invention, when the external substrate with which optical elements, such as a light emitting device and a photo detector, were mounted is connected to the side in which the above-mentioned optical waveguide is formed through a solder bump, the above-mentioned multilayer printed wiring board and the above-mentioned external substrate can be certainly arranged to a position according to the self-alignment operation which solder has. Therefore, if the installation location of the optical waveguide in the multilayer printed wiring board of this invention and the installation location of the optical element in the above-mentioned external substrate are exact, an exact lightwave signal can be transmitted among both.

[0069] In addition, in order that, as for a self-alignment operation, a solder resist layer may crawl solder, solder says the operation to which it is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity which self has at the time of reflow processing. Though location gap has occurred to both in front of a reflow in case the above-mentioned external substrate is connected the above-mentioned multilayer printed wiring board top through the above-mentioned solder bump when this self-alignment operation is used, the above-mentioned external substrate can move at the time of a reflow, and this external substrate can be attached in the exact location on the above-mentioned multilayer printed wiring board.

[0070] An example of the operation gestalt of the multilayer printed wiring board which consists of the above-mentioned configuration hereafter is explained referring to a drawing. both sides of the substrate with which optical waveguide was here formed in a part of the front face — a conductor — a circuit and the resin insulating layer between layers explain the multilayer printed wiring board by which laminating formation was carried out.

Drawing 1 is the sectional view showing typically 1 operation gestalt of the multilayer printed wiring board of this invention.
[0071] it is shown in drawing 1 — as — a multilayer printed wiring board 100 — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the resin insulating layer [a circuit 124 and] 122 between layers was pinched — the conductor which sandwiched the resin insulating layer 122 between layers between circuits — between circuits, the through hole 129 and the Bahia hall 127 connect electrically, and the solder resist layer 134 is formed in the outermost layer of drum, respectively.
[0072] moreover — substrate 121 front face — the conductor of the lowest layer — the opening 138 (138a, 138b) for optical paths is formed [the part in which optical waveguide 150 (150a, 150b) is formed in with the circuit 124 and the optical-path conversion mirror 151 (151a, 151b) at the head of optical waveguide 150 was formed] perpendicularly at the substrate 121. Moreover, this opening 138 for optical paths is filled up with the resin 152 which does not check transmission of a lightwave signal. In addition, one side is the optical waveguide for light-receiving, and another side of optical waveguides 150a and 150b is the optical waveguide for luminescence.
[0073] In the multilayer printed wiring board 100 which consists of such a configuration, the lightwave signal sent from the outside through an optical fiber (not shown) etc. will be introduced into optical waveguide 150a, and will be sent to a photo detector (not shown) etc. through optical-path conversion mirror 151a and opening 138a for optical paths. moreover, the lightwave signal sent out from the light emitting device (not shown) etc. is conversion mirror [optical] 151b minded from opening 138for optical paths b, is introduced into optical waveguide 150b, and is delivery outside as a lightwave signal through an optical fiber (not shown) etc. further — it will be carried out.
[0074] Moreover, when external substrates (not shown), such as IC chip mounting substrate, are connected through the solder bump 137, a multilayer printed wiring board 100 and an external substrate can be connected electrically, and further, when the optical element is mounted in this external substrate, a lightwave signal and an electrical signal can be transmitted between a multilayer printed wiring board 100 and an external substrate.
[0075] In addition, although the optical waveguide containing a particle is formed on the surface of the substrate in the multilayer printed wiring board mentioned above, this optical waveguide can acquire the effectiveness mentioned above also in the multilayer printed wiring board formed between parts other than a substrate front face, i.e., the resin insulating layers between layers, and on the resin insulating layer between layers of an outermost layer of drum. Moreover, the crevice is formed in a part of substrate or resin insulating layer between layers depending on the case, and optical waveguide may be formed in this crevice. Furthermore, a solder resist layer may be formed in an outermost layer of drum, and optical waveguide may be formed in a part of the front face.
[0076] Next, how to manufacture the multilayer printed wiring board of this invention is explained. in addition, both sides of the substrate with which optical waveguide was mainly formed in a part of the front face here — a conductor — a circuit and the resin insulating layer between layers explain how to manufacture the multilayer printed wiring board by which laminating formation was carried out. Of course, it is not limited to the approach of manufacturing the multilayer printed wiring board of this invention, and the following approach.
[0077] (1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit. As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester substrate, a polyimide substrate, a bismaleimide-triazine (BT) resin substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example. Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used. the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.
[0078] moreover, the thing for which etching processing is performed — a conductor — forming a electroplating layer in the plating-resist agenesis section, and removing the conductor layer under plating resist and this plating resist after that, after replacing with the approach of forming a circuit and forming plating resist on a solid conductor layer — a conductor — the approach of forming a circuit — using — a conductor — a circuit may be formed.
[0079] moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-mentioned insulating substrate and forming a breakthrough, the through hole is formed by performing nonelectrolytic plating processing etc. In addition, the diameter of the above-mentioned breakthrough is usually

100-300 micrometers. Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.

[0080] (2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit. as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. can be mentioned. the case where a roughening side is formed here — the average relative roughness of this roughening side — usually — 0.1-5 micrometers — desirable — a conductor — the adhesion of a circuit and the resin insulating layer between layers, and a conductor — when the effect to the electrical signal transmission ability of a circuit etc. is taken into consideration, 2-4 micrometers is more desirable. In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.

[0081] (3) next, the conductor on a substrate — form optical waveguide in the circuit agenesis section. It forms by specifically sticking on a substrate the optical waveguide of the shape of a film produced using the resin constituent for optical waveguides of this invention. Moreover, formation of optical waveguide is good in a direct line on the above-mentioned substrate. In this case, formation of optical waveguide can be performed using the approach of using the resin constituent for optical waveguides of this invention, and forming optical waveguide on the base material mentioned above, for example, and the same approach. in addition, the formation process of optical waveguide — a substrate top — a conductor — you may carry out, before forming a circuit.

[0082] Moreover, formation of optical waveguide may form optical waveguide directly on a substrate from using the resin constituent for optical waveguides of this invention on a substrate, and carrying out sequential formation of the undershirt clad section, the core section, and the exaggerated clad section.

[0083] Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide. Although it may be formed before the above-mentioned optical-path conversion mirror attaches optical waveguide on a substrate, and it may be formed after attaching it on a substrate, it is desirable to form an optical-path conversion mirror beforehand except for the case where this optical waveguide is directly formed on a substrate. the member of the multilayer printed wiring board which can work easily and constitutes a multilayer printed wiring board at the time of an activity, for example, a conductor, — it is because a blemish is given to a circuit, a substrate, etc. or there is no possibility of damaging these.

[0084] It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose head is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.

[0085] (4) next, optical waveguide and a conductor — form the resin layer which forms the resin layer which is not hardened [which some of thermosetting resin photopolymers, and thermosetting resin become from the acrylic-ized resin, these and thermoplastics, and the included resin complex] on the substrate in which the circuit was formed, or consists of thermoplastics. The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening). Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated on the film.

[0086] In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc. Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.

[0087] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example. As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.

[0088] As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example. Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic--ization-react as resin which acrylic-ized some above-mentioned thermosetting resin for example, is mentioned.

[0089] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF), polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.

[0090] Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin which acrylic-ized some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a photopolymer and thermoplastics, acrylic resin/phenoxy resin, an epoxy resin / polyether sulfone etc. that acrylic-ized a part of epoxy group are mentioned, for example.

[0091] Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.

[0092] Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer. It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc. While securing the adhesion which was excellent with the insulating substrate etc. by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls etc. at an after process is securable.

[0093] Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation. The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer. In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.

[0094] In case the above-mentioned roughening liquid is used for the resin insulating layer between layers and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, by using a photopolymer, exposure and a development may be used for the resin insulating layer between layers, and opening for the Bahia halls may be formed.

[0095] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)--ization-react using a methacrylic acid, an acrylic acid, etc.

[0096] As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.

[0097] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.

[0098] As matter of fusibility, an inorganic particle, a resin particle, metal particles, a rubber particle, liquid phase resin, liquid phase rubber, etc. are mentioned to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer, for example, and an inorganic particle, a resin particle, and metal particles are desirable in these. Moreover, these may be used independently and may be used together two or more sorts.

[0099] As the above-mentioned inorganic particle, what consists of silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, basic magnesium carbonate, and talc, a silica, and a zeolite, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts. Dissolution clearance of the above-mentioned alumina particle can be carried out by fluoric acid, and dissolution clearance of the calcium

carbonate can be carried out with a hydrochloric acid. Moreover, dissolution clearance of a sodium content silica or the dolomite can be carried out in an alkali water solution.

[0100] As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, what consists of amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. is mentioned. These may be used independently and may be used together two or more sorts. In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle dissolves in the solvent in which a resin matrix is dissolved, so homogeneity will be mixed and dissolution clearance only of the resin particle can be selectively carried out neither with an acid nor an oxidizer, unless it makes it harden.

[0101] As the above-mentioned metal particles, what consists of gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts. Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.

[0102] When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the resin insulating layer between layers which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of the resin insulating layer between layers — a crack — not generating — the resin insulating layer between layers, and a conductor — it is because exfoliation does not occur between circuits.

[0103] It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid, for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. It is because it is hard to make the metallic conductor layer exposed from the Bahia hall corrode when roughening processing is carried out. Moreover, a sodium hydroxide, a potassium hydroxide, etc. are mentioned as the above-mentioned alkali. As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example.

[0104] The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less. Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.8 micrometers, and the matter of the fusibility whose mean particle diameter's is 0.8-2.0 micrometers etc.

[0105] Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of the nonelectrolytic plating film can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed. Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the practical Peel reinforcement is maintainable.

[0106] (5) Next, in forming the resin insulating layer between layers using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as the resin insulating layer between layers. Moreover, at this process, a breakthrough may be formed if needed. As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of the resin insulating layer between layers, you may form by the exposure development.

[0107] Moreover, in forming the resin insulating layer between layers using thermoplastics as the ingredient, opening for the Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as the resin insulating layer between layers. In this case, opening for the Bahia halls can be formed by giving the lasing. Moreover, what is necessary is just to form this breakthrough by drilling, the lasing, etc., when forming a breakthrough at this process.

[0108] As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.

[0109] Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed efficiently by laser radiation by

using this method.
[0110] Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds. Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts. Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.
[0111] (6) Next, form a thin film conductor layer in the front face of the resin insulating layer between layers including the wall of opening for the Bahia halls. The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.
[0112] As construction material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example. In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, profitability, etc. is desirable. Moreover, as thickness of the above-mentioned thin film conductor layer, when forming a thin film conductor layer with nonelectrolytic plating, 0.3-2.0 micrometers is desirable and 0.6-1.2 micrometers is more desirable. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable. In addition, in forming a thin film conductor layer with nonelectrolytic plating, it gives the catalyst beforehand to the front face of the resin insulating layer between layers. As the above-mentioned catalyst, a palladium chloride etc. is mentioned, for example.
[0113] Moreover, a roughening side may be formed in the front face of the resin insulating layer between layers before forming the above-mentioned thin film conductor layer. By forming a roughening side, the adhesion of the resin insulating layer between layers and a thin film conductor layer can be raised.
[0114] Moreover, when a breakthrough is formed at the process of the above (5), in case a thin film conductor layer is formed on the resin insulating layer between layers, it is good also as a through hole by forming a thin film conductor layer also in the wall surface of a breakthrough.
[0115] (7) Subsequently, form plating resist on the substrate with which the thin film conductor layer was formed in the front face. After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.
[0116] (8) After that, perform electrolysis plating by making a thin film conductor layer into a plating bar, and form an electrolysis plating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electrolysis plating, copper plating is desirable. Moreover, the thickness of the above-mentioned electrolysis plating layer has desirable 5-20 micrometers. then, the thing for which the nonelectrolytic plating film and thin film conductor layer under the above-mentioned plating resist and this plating resist are removed -- a conductor -- a circuit (the Bahia hall is included) can be formed. What is necessary is just to perform clearance of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform clearance of the above-mentioned plating resist for example, using an alkali water solution etc. moreover, the above -- a conductor -- after forming a circuit, the catalyst on the resin insulating layer between layers may be removed using an acid or an oxidizer if needed. It is because lowering of an electrical property can be prevented. passing through the process of such (6) - (8) -- a conductor -- a circuit can be formed.
[0117] in addition -- although the approach of above-mentioned (6) - (8) is a semiadditive process -- this approach -- replacing with -- a fully-additive process -- a conductor -- a circuit may be formed. the conductor which used the dry film for the part on this electrolysis plating layer, formed etching resist, removed an etching-resist agenesis subordinate's electrolysis plating layer and thin film conductor layer by etching after that, and became independent by exfoliating etching resist further after specifically forming an electrolysis plating layer the whole surface on the thin film conductor layer formed by the same approach as the above (6) -- a circuit may be formed.
[0118] the conductor of others [additive process / such], such as a subtractive process, -- the manufacture approach of a circuit -- comparing -- since etching precision is high -- a more detailed conductor -- while being able to form a circuit -- a conductor -- the degree of freedom of a design of a circuit improves. in addition, a case -- a subtractive process -- a conductor -- a circuit may be formed.
[0119] Moreover, when a through hole is formed in the above (5) and the process of (6), it may be filled up with a resin filler in this through hole. Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed.
[0120] (9) next, the thing for which roughening processing is performed on the front face of this lid plating layer,

and the process of (4) – (8) is further repeated if needed when a lid plating layer is formed — the both sides — the resin insulating layer between layers, and a conductor — carry out laminating formation of the circuit. In addition, a through hole may be formed and it is not necessary to form at this process.
[0121] (10) Next, form the solder resist layer of an outermost layer of drum. The above-mentioned solder resist layer can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.
[0122] moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 – 10 Pa-s at 25 degrees C. By forming the above-mentioned solder resist layer in an outermost layer of drum, the above-mentioned optical waveguide can be protected from breakage, heat, etc.
[0123] (11) Next, while forming opening for solder bump formation in the above-mentioned solder resist layer if needed, form in one side of a substrate opening which penetrates a solder resist layer and the resin insulating layer between layers and which was open for free passage. Specifically, formation of the above-mentioned opening for solder bump formation can be performed using the approach of forming opening for the Bahia halls, and the same approach, i.e., an exposure development and the lasing. Moreover, the diameter of opening of the above-mentioned opening for solder bump formation has desirable 100-300 micrometers.
[0124] Moreover, for example, an exposure development, the lasing, etc. perform formation of opening (opening for optical paths) which penetrates the above-mentioned solder resist layer and the resin insulating layer between layers and which was open for free passage. the above-mentioned lasing — as the laser been and used — formation of the above-mentioned opening for the Bahia halls — it is and the same thing as the laser to be used etc. is mentioned. In this case, it is desirable to use the laser of the wavelength in which the above-mentioned optical waveguide does not have absorption as the above-mentioned laser. It is because there are few possibilities of damaging the above-mentioned optical waveguide front face when forming the above. moreover, the formation location of the above-mentioned opening for optical paths will be limited especially if it is the location which can transmit the lightwave signal from optical waveguide, and the signal to optical waveguide — not having — a conductor — what is necessary is just to choose suitably in consideration of the design of a circuit etc.
[0125] The diameter of opening of the above-mentioned opening for optical paths has desirable 50-200 micrometers. Moreover, especially the configuration is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In addition, as mentioned above, formation of opening for optical paths may be performed after it forms a solder resist layer, but after forming the resin insulating layer between layers, and it forms opening for optical paths once depending on the case and forms a solder resist layer, forms opening which was open for free passage again to opening for optical paths prepared in the resin insulating layer between layers, and is good also as opening for optical paths. It is because it is sometimes difficult to form opening for optical paths by the lasing once depending on the thickness of the resin insulating layer between layers, or a solder resist layer.
[0126] Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.
[0127] (12) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold. Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer.
[0128] Moreover, it is desirable to fill up resin with this process in opening for optical paths formed at the process of the above (11), before forming a solder pad. Thus, while being able to acquire the effectiveness mentioned above by being filled up with resin, in case a solder pad is formed, it is because plating liquid etc. does not enter in opening for optical paths. Moreover, formation of opening for optical paths performed at the process of the above (11) may be performed after forming a solder pad at this process. In case a solder pad is formed also in this case, it is because plating liquid etc. does not enter in opening for optical paths.
[0129] (13) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-

mentioned solder pad. Moreover, it is good also as PGA or BGA by using electroconductive glue etc., arranging a pin or forming a solder ball in an external substrate connection side in the solder resist layer of a field and an opposite hand which forms optical waveguide. Although not limited especially as the above-mentioned pin, the pin of T mold is desirable. Moreover, as the construction material, covar, 42 alloys, etc. are mentioned, for example. By passing through such a process, the multilayer printed wiring board of this invention can be manufactured.
[0130] Moreover, although the manufacture approach of a multilayer printed wiring board that optical waveguide was formed on the substrate was explained here, the approach mentioned above and the same approach can be used except forming optical waveguide on the resin insulating layer between layers instead of forming optical waveguide on a substrate, in manufacturing the multilayer printed wiring board with which optical waveguide was formed on the resin insulating layer between layers.
[0131]
[Example] Hereafter, this invention is further explained to a detail.
(Example 1)
A. The preparation acrylic resin 40 weight section of the resin constituent for optical waveguides (the resin constituent for clads, and resin constituent for cores), As the acrylate system monomer 10 weight section and a curing agent, the imidazole curing agent 4 weight section, As a photopolymerization initiator, as the benzophenone 5 weight section and a solvent The ethyl lactate 40 weight section, Stirring mixing of the stabilizer 1 weight section and the silica particle (particle size distribution of 1-10 micrometers, mean particle diameter of 5 micrometers) was carried out, and the viscosity prepared the resin constituent for optical waveguides of 5**1 Pa-s in 25 degrees C by rotational frequency 5min-1 (rpm). In addition, the transmittance of the resin constituent for optical waveguides before the loadings of a silica particle are 50 % of the weight and add a silica particle into the produced optical waveguide was 95%. Moreover, the refractive index was made small by fluorinating a part of C-H of the above-mentioned resin constituent for optical waveguides (C-F), and the resin constituent for clads (refractive index 1.54 after hardening) was prepared. Furthermore, a part of C-H of the above-mentioned resin constituent for optical waveguides was deuterated (C-D), the refractive index was enlarged, and the resin constituent for cores (refractive index 1.56 after hardening) was prepared. In addition, the permeability (850nm) after hardening of the prepared resin constituent for clads and the resin constituent for cores was 90%.
[0132] B. Production (1) which is optical waveguide The undershirt clad section was first formed on the base material by carrying out spreading membrane formation of the resin constituent for the clad sections prepared by A by 50 micrometers in thickness using a spin coater, carrying out temporary hardening of this the condition for 80 degrees C and 20 minutes, carrying out after exposure by 2000mJ, and carrying out heat hardening the condition for 60 minutes at 140 degrees C. In addition, as a base material, thickness is 10mm and the base material which consists of a ceramic by which polish processing was performed to the front face was used.
[0133] (2) Next, the thickness after hardening carried out spreading membrane formation of the resin constituent for the core sections prepared by A by 50 micrometers on the undershirt clad section, temporary hardening of this was carried out the condition for 20 minutes at 80 degrees C, and it exposed by 500mJ, and further, by performing a development, after setting the width of face to 50 micrometers, heat hardening was carried out the condition for 60 minutes at 150 degrees C, and the core section was formed. In addition, the skin was formed in the front face of the layer after temporary hardening processing.
[0134] (3) Next, after having carried out spreading membrane formation of the resin constituent for the clad sections so that the thickness on the core section might be set to 50 micrometers, and carrying out temporary hardening of this the condition for 20 minutes at 80 degrees C on the undershirt clad section (a core section top is included), by exposing by 2000mJ and carrying out heat hardening the condition for 60 minutes by 140, the exaggerated clad section was formed and it considered as optical waveguide. In addition, the thickness of the formed optical waveguide is 150 micrometers.
[0135] (Example 2) After having used polymethylmethacrylate (PMMA) as a resinous principle, using the titania particle as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the titania particle in the produced optical waveguide were 70 % of the weight.
[0136] (Example 3) After having used UV hardenability epoxy resin as a resinous principle, using the copper grain child as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical

waveguides. In addition, the loadings of the copper grain child in the produced optical waveguide were 20 % of the weight.

[0137] (Example 4) After having used deuteration silicone resin as a resinous principle, using the alumina particle as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the alumina particle in the produced optical waveguide were 20 % of the weight.

[0138] (Example 5) After preparing the resin constituent for optical waveguides using the resin particle which hardened UV hardenability acrylate resin as a resinous principle, and hardened the epoxy resin as a particle, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the resin particle which hardened the epoxy resin in the produced optical waveguide were 30 % of the weight.

[0139] (Example 6) After having used fluorination polyimide as a resinous principle, using the silica particle and the CHITANI particle as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of that of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the silica particle in the produced optical waveguide and a titania particle were 40 % of the weight.

[0140] (Example 7) After preparing the resin constituent for optical waveguides using the particle formed after fusing polyolefin resin as a resinous principle and fusing a silica and a titania as a particle, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the particle formed after fusing the silica and titania in the produced optical waveguide were 60 % of the weight.

[0141] (Example 8) Except having used 0.2-0.8 micrometers of particle size distribution, and a silica particle with a mean particle diameter of 0.5 micrometers, the resin constituent for optical waveguides was prepared like the example 1, and optical waveguide was produced.

[0142] (Example 9) Except having used 5-30 micrometers of particle size distribution, and a silica particle with a mean particle diameter of 15 micrometers, the resin constituent for optical waveguides was prepared like the example 1, and optical waveguide was produced.

[0143] (Example 1 of a comparison) Optical waveguide was produced like the example 1 except having not blended a particle.

[0144] (Example 1 of reference) Optical waveguide was produced like the example 1 except having blended the silica particle so that the loadings of the particle in the produced optical waveguide might become 5% of the weight.

[0145] (Example 2 of reference) Optical waveguide was produced like the example 1 except having blended the silica particle so that the loadings of the particle in the produced optical waveguide might become 90% of the weight.

[0146] (Example 3 of reference) Optical waveguide was produced like the example 2 except having blended the titania particle so that the loadings of the particle in the produced optical waveguide might become 2% of the weight.

[0147] (Example 4 of reference) Optical waveguide was produced like the example 2 except having blended the titania particle so that the loadings of the particle in the produced optical waveguide might become 85% of the weight.

[0148] (Example 5 of reference) Optical waveguide was produced like the example 3 except having blended the copper grain child so that the loadings of the particle in the produced optical waveguide might become 8% of the weight.

[0149] (Example 6 of reference) Optical waveguide was produced like the example 3 except having blended the copper grain child so that the loadings of the particle in the produced optical waveguide might become 87% of the weight.

[0150] About the optical waveguide produced in examples 1-9, the example 1 of a comparison, and the examples 1-6 of reference, perform the reliability trial left under 135 degrees C and conditions of 85% of relative humidity for 100 hours, and it sets before and after this reliability trial. When the transmission loss of a lightwave signal with a wavelength of 0.85 micrometers is measured, in the optical waveguide of examples 1-9 In the optical waveguide of the example 1 of a comparison, the rate of increase of transmission loss was 25% or more to the

rate of increase of transmission loss having been 15% or less, and the rate of increase of transmission loss was 15 - 20% in the optical waveguide of the examples 1-6 of reference. In addition, the rate of increase of transmission loss was computed from the following formula (1).
[0151]
Rate-of-increase =[(difference of transmission loss before and behind reliability trial)/(transmission loss before reliability trial)] x100 of transmission loss ... (1)
[0152] Moreover, it observed whether exfoliation would have occurred between whether about the optical waveguide produced by the optical waveguide of examples 1-9, before and after the above-mentioned reliability trial, configuration observation was performed and the crack has occurred, a base material, and optical waveguide. Consequently, in the optical waveguide of examples 1-9, neither generating of a crack nor generating of exfoliation between a base material and optical waveguide was observed before and after the reliability trial.
[0153] (Example 10)
A. The production bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section of the resin film for the resin insulating layers between layers, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, Dainippon Ink & Chemicals, Inc. make FENO light KA-7052) 30 weight section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicon system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared. After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating layers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0154] The mean particle diameter by which coating of the silane coupling agent was carried out to the preparation bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section of the resin constituent for breakthrough restoration and a front face B. By 1.6 micrometers the diameter of grain of maximum size — SiO2 spherical particle (the Adtec Corp. make —) 15 micrometers or less CRS The viscosity prepared the resin filler of 45 - 49 Pa-s at 23**1 degree C by carrying out stirring mixing of the 1101-CE170 weight section and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section for a container. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.
[0155] C. Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.8mm or BT (bismaleimide triazine) resin of a multilayer printed wiring board was used as the start ingredient (refer to drawing 2 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 21 — a conductor — the circuit 24 and the through hole 29 were formed.
[0156] (2) a through hole 29 and a conductor — the conductor which washes in cold water the substrate in which the circuit 24 was formed, carries out software etching after carrying out acid cleaning, and, subsequently to both sides of a substrate, includes the through hole 29 by sending with a conveyance roll after spraying an etching reagent by the spray — the roughening side (not shown) was formed in the front face of a circuit 24. As an etching reagent, it is imidazole copper. The etching reagent (the product made from MEKKU, MEKKU dirty bond) which consists of the (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0157] (3) Next, the optical waveguide 50 which uses the following approaches for the position on a substrate, and has the optical-path conversion mirror 51 was formed (refer to drawing 2 (b)). That is, the head forms 45-degree optical-path conversion mirror in the end of the optical waveguide produced in the example 1 using the diamond saw which is 90 degrees of V types, and this optical waveguide was stuck so that the side face of that other end by the side of optical conversion mirror agenesis and the side face of a substrate might gather. In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the substrate of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour. In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.
[0158] (4) the following approach after preparing the resin filler indicated to Above B — after preparation — less

than 24 hours — the conductor of one side of the inside of a through hole 29, and a substrate 21 — the circuit agenesis section, the optical waveguide agenesis section, and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24 (refer to drawing 2 (c)). That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section (the optical waveguide agenesis section is included) lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes. subsequently, the conductor of the field of another side — the circuit agenesis section (the optical waveguide agenesis section is included) and a conductor — the layer of resin filler 30' was formed like the rim section of a circuit (refer to drawing 2 (c)).
[0159] (5) the belt sander [one side / which finished processing of the above (4) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0160] thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor — the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 2 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.
[0161] (6) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, the land front face of a through hole 29, and a wall — a conductor — the roughening side was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0162] (7) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by Above A was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 22 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 2 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.
[0163] (8) Next, mind the mask with which the breakthrough with a thickness of 1.2mm was formed on the resin insulating layer 22 between layers, and it is CO2 with a wavelength of 10.4 micrometers. By gas laser, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 22 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 3 (a)).
[0164] (9) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers. Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0165] (10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the

Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 3 (b)).
[Nonelectrolytic plating water solution]
NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol (PEG) 0.10 g/l [nonelectrolytic plating conditions] It is 40 minutes [0166] by whenever [30-degree C solution temperature]. (11) Next, stick a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, lay a mask, and it is 100 mJ/cm2. The plating resist 23 with a thickness of 20 micrometers was formed by exposing and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 3 (c)).
[0167] (12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 3 (d)).
[Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0168] (13) — a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under the plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution clearance and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation clearance of the plating resist 23 by NaOH 5% — the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 4 (a)).
[0169] (14) next, the thing for which the process of above-mentioned (6) - (13) is repeated — the upper resin insulating layer between layers, and a conductor — laminating formation of the circuit was carried out (refer to drawing 4 (b) - drawing 5 (b)). furthermore, the approach used at the process of the above (6) and the same approach — using — the conductor of an outermost layer of drum — the roughening side (not shown) was formed in the circuit 25 (the Bahia hall 27 is included), and the multilayer-interconnection plate was obtained.
[0170] (15) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation — shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 3.0 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent. In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold). In addition, a commercial solder resist constituent can also be used as the above-mentioned solder resist constituent.
[0171] (16) Next, the above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of a multilayer-interconnection plate the condition for 30 minutes at 70 degrees C, and the layer of a solder resist constituent was formed in them.
[0172] (17) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical paths was drawn was stuck in the layer of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening for solder bump formation of 200 micrometers of diameters of opening, becoming opening, and opening for optical paths of 150 micrometers of diameters of opening and becoming opening were formed. Furthermore, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, the layer of a solder resist constituent is stiffened, it has the opening 39 for solder bump formation, and opening for optical paths, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed. Furthermore, the above-mentioned opening for optical paths and opening which was open for free passage were formed in the resin insulating layer between layers by giving

the lasing.

[0173] (18) Next, DESUMIA processing was performed to the wall surface of the opening 38 for optical paths formed in the resin insulating layer between a solder resist layer and layers (refer to drawing 6 (a)). Furthermore, the opening 38 for optical paths was made to fill up with and harden the resin constituent containing acrylic resin, and the resin layer 52 for optical paths was formed.

[0174] (19) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 15 for solder bump formation. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10-1 mol/l), a sodium citrate (1.2x10 to 1 mol/l.), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36 (refer to drawing 6 (b)).

[0175] (20) Next, by printing soldering paste to the opening 15 for solder bump formation formed in the solder resist layer 14, and carrying out a reflow at 200 degrees C, the solder bump 17 was formed in the opening 15 for solder bump formation, and it considered as the multilayer printed wiring board (refer to drawing 1).

[0176] (Example 11) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 2.

[0177] (Example 12) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 3.

[0178] (Example 13) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 4.

[0179] (Example 14) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 5.

[0180] (Example 15) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 6.

[0181] (Example 16) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 7.

[0182] (Example 17) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 8.

[0183] (Example 18) In the process of (3) of an example 10, the multilayer printed wiring board was manufactured like the example 10 by passing through the process of following (i) - (iii) except having produced optical waveguide.

(i) The undershirt clad section was formed by carrying out spreading membrane formation of the resin constituent for the clad sections prepared in the example 1 by 50 micrometers in thickness using a spin coater, carrying out temporary hardening of this the condition for 80 degrees C and 20 minutes, carrying out after exposure by 2000mJ, and carrying out heat hardening to the position on a substrate the condition for 60 minutes at 140 degrees C first.

[0184] (ii) Next, by the thickness after hardening carrying out spreading membrane formation of the resin constituent for the core sections prepared in the example 1 by 50 micrometers on the undershirt clad section, carrying out temporary hardening of this the condition for 20 minutes at 80 degrees C, and performing exposure and a development by 500mJ, after setting the width of face to 50 micrometers, heat hardening was carried out the condition for 60 minutes at 150 degrees C, and the core section was formed. In addition, the skin was formed in the front face of the layer after temporary hardening processing.

[0185] (iii) Next, after having carried out spreading membrane formation of the resin constituent for the clad sections so that the thickness on the core section might be set to 50 micrometers, and carrying out temporary hardening of this the condition for 20 minutes at 80 degrees C on the undershirt clad section (a core section top is included), by exposing by 2000mJ and carrying out heat hardening the condition for 60 minutes by 140, the exaggerated clad section was formed and it considered as optical waveguide. In addition, the thickness of the formed optical waveguide was 150 micrometers.

[0186] The following assessment approach estimated the multilayer printed wiring board obtained in the examples 10-18 by performing configuration observation of (1) optical waveguide, detection of (2) lightwave signals, and (3) continuity checks.
[0187] About the multilayer printed wiring board of the configuration observation examples 10-18 of the assessment approach (1) optical waveguide, the cutter cut these multilayer printed wiring boards so that it might pass along optical waveguide, and the cross section was observed.
[0188] (2) The substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the side in which the optical waveguide of detection **** of a lightwave signal and the multilayer printed wiring board of examples 10-18 is formed was connected through the solder bump so that it might be arranged in the location where a photo detector and a light emitting device counter opening for optical paths, respectively. Next, after attaching a detector in an exposed surface from the multilayer printed wiring board side face of the optical waveguide which counters installation and a photo detector in an optical fiber at an exposed surface from the multilayer printed wiring board side face of the optical waveguide which counters a light emitting device and making a lightwave signal calculate with delivery and IC chip through an optical fiber, the detector detected the lightwave signal.
[0189] (3) Like detection of the continuity-check above-mentioned lightwave signal, the substrate for IC chip mounting was connected to the multilayer printed wiring board, the continuity check was performed after that, and switch-on was evaluated from the result displayed on a monitor.
[0190] As for the multilayer printed wiring board of examples 10-18, two kinds of optical waveguides, the optical waveguide for light-receiving and the optical waveguide for luminescence, were formed in the position as a result of the above-mentioned assessment. Moreover, in the multilayer printed wiring board of examples 10-18, the multilayer printed wiring board which connected the substrate for IC chip mounting, could detect the desired lightwave signal when a lightwave signal was transmitted, and was manufactured by this example became clear [having sufficient lightwave signal transmission ability]. Furthermore, in the multilayer printed wiring board of examples 10-18, in the continuity check at the time of connecting the substrate for IC chip mounting through a solder bump, it was satisfactory to the conductivity of an electrical signal, and it became clear that an electrical signal can also be transmitted with a lightwave signal.
[0191]
[Effect of the Invention] Since the resin constituent for optical waveguides of this invention consists of a configuration mentioned above, when forming optical waveguide on a base material etc. using this resin constituent for optical waveguides The optical waveguide which consists of the above-mentioned resin constituent for optical waveguides which hardly generated the crack and exfoliation resulting from the difference of a coefficient of thermal expansion, and was formed on the base material etc. In the carrier beam case, since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity, the balance in the TM0 mode of optical waveguide and the TE0 mode does not almost collapse the heat history, and a lightwave signal can be transmitted good.
[0192] Since the optical waveguide of this invention consists of a configuration mentioned above, when formed on the base material etc., this optical waveguide The above-mentioned optical waveguide which hardly generated the crack and exfoliation resulting from the difference of a coefficient of thermal expansion, and was formed on the base material etc. In the carrier beam case, since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity, the balance in the TM0 mode of optical waveguide and the TE0 mode does not almost collapse the heat history, and a lightwave signal can be transmitted good.
[0193] Since the multilayer printed wiring board of this invention consists of a configuration mentioned above, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, and a substrate and the resin insulating layer between layers. The crack and exfoliation resulting from the difference of a coefficient of thermal expansion are hardly generated. Moreover, the above-mentioned optical waveguide Since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are at abbreviation homogeneity even if it receives the heat history, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses, and a lightwave signal can be transmitted good. moreover, the above-mentioned multilayer printed wiring board — a conductor — since optical waveguide is built in in the multilayer printed wiring board while being able to transmit both a lightwave signal and an electrical signal, since a circuit and optical waveguide are formed, it can contribute to the miniaturization of the terminal equipment for optical communication.

[Translation done.]

EXAMPLE

[Example] Hereafter, this invention is further explained to a detail.
(Example 1)
A. The preparation acrylic resin 40 weight section of the resin constituent for optical waveguides (the resin constituent for clads, and resin constituent for cores), As the acrylate system monomer 10 weight section and a curing agent, the imidazole curing agent 4 weight section, As a photopolymerization initiator, as the benzophenone 5 weight section and a solvent The ethyl lactate 40 weight section, Stirring mixing of the stabilizer 1 weight section and the silica particle (particle size distribution of 1-10 micrometers, mean particle diameter of 5 micrometers) was carried out, and the viscosity prepared the resin constituent for optical waveguides of 5**1 Pa-s in 25 degrees C by rotational frequency 5min-1 (rpm). In addition, the transmittance of the resin constituent for optical waveguides before the loadings of a silica particle are 50 % of the weight and add a silica particle into the produced optical waveguide was 95%. Moreover, the refractive index was made small by fluorinating a part of C-H of the above-mentioned resin constituent for optical waveguides (C-F), and the resin constituent for clads (refractive index 1.54 after hardening) was prepared. Furthermore, a part of C-H of the above-mentioned resin constituent for optical waveguides was deuterated (C-D), the refractive index was enlarged, and the resin constituent for cores (refractive index 1.56 after hardening) was prepared. In addition, the permeability (850nm) after hardening of the prepared resin constituent for clads and the resin constituent for cores was 90%.
[0132] B. Production (1) which is optical waveguide The undershirt clad section was first formed on the base material by carrying out spreading membrane formation of the resin constituent for the clad sections prepared by A by 50 micrometers in thickness using a spin coater, carrying out temporary hardening of this the condition for 80 degrees C and 20 minutes, carrying out after exposure by 2000mJ, and carrying out heat hardening the condition for 60 minutes at 140 degrees C. In addition, as a base material, thickness is 10mm and the base material which consists of a ceramic by which polish processing was performed to the front face was used.
[0133] (2) Next, the thickness after hardening carried out spreading membrane formation of the resin constituent for the core sections prepared by A by 50 micrometers on the undershirt clad section, temporary hardening of this was carried out the condition for 20 minutes at 80 degrees C, and it exposed by 500mJ, and further, by performing a development, after setting the width of face to 50 micrometers, heat hardening was carried out the condition for 60 minutes at 150 degrees C, and the core section was formed. In addition, the skin was formed in the front face of the layer after temporary hardening processing.
[0134] (3) Next, after having carried out spreading membrane formation of the resin constituent for the clad sections so that the thickness on the core section might be set to 50 micrometers, and carrying out temporary hardening of this the condition for 20 minutes at 80 degrees C on the undershirt clad section (a core section top is included), by exposing by 2000mJ and carrying out heat hardening the condition for 60 minutes by 140, the exaggerated clad section was formed and it considered as optical waveguide. In addition, the thickness of the formed optical waveguide is 150 micrometers.
[0135] (Example 2) After having used polymethylmethacrylate (PMMA) as a resinous principle, using the titania particle as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic

using this resin constituent for optical waveguides. In addition, the loadings of the titania particle in the produced optical waveguide were 70 % of the weight.
[0136] (Example 3) After having used UV hardenability epoxy resin as a resinous principle, using the copper grain child as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the copper grain child in the produced optical waveguide were 20 % of the weight.
[0137] (Example 4) After having used deuteration silicone resin as a resinous principle, using the alumina particle as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the alumina particle in the produced optical waveguide were 20 % of the weight.
[0138] (Example 5) After preparing the resin constituent for optical waveguides using the resin particle which hardened UV hardenability acrylate resin as a resinous principle, and hardened the epoxy resin as a particle, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the resin particle which hardened the epoxy resin in the produced optical waveguide were 30 % of the weight.
[0139] (Example 6) After having used fluorination polyimide as a resinous principle, using the silica particle and the CHITANI particle as a particle and preparing the resin constituent for optical waveguides, optical waveguide was produced by carrying out laminating formation of that of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the silica particle in the produced optical waveguide and a titania particle were 40 % of the weight.
[0140] (Example 7) After preparing the resin constituent for optical waveguides using the particle formed after fusing polyolefin resin as a resinous principle and fusing a silica and a titania as a particle, optical waveguide was produced by carrying out laminating formation of the undershirt clad section, the core section, and the exaggerated clad section in this order on the substrate which consists of a ceramic using this resin constituent for optical waveguides. In addition, the loadings of the particle formed after fusing the silica and titania in the produced optical waveguide were 60 % of the weight.
[0141] (Example 8) Except having used 0.2-0.8 micrometers of particle size distribution, and a silica particle with a mean particle diameter of 0.5 micrometers, the resin constituent for optical waveguides was prepared like the example 1, and optical waveguide was produced.
[0142] (Example 9) Except having used 5-30 micrometers of particle size distribution, and a silica particle with a mean particle diameter of 15 micrometers, the resin constituent for optical waveguides was prepared like the example 1, and optical waveguide was produced.
[0143] (Example 1 of a comparison) Optical waveguide was produced like the example 1 except having not blended a particle.
[0144] (Example 1 of reference) Optical waveguide was produced like the example 1 except having blended the silica particle so that the loadings of the particle in the produced optical waveguide might become 5% of the weight.
[0145] (Example 2 of reference) Optical waveguide was produced like the example 1 except having blended the silica particle so that the loadings of the particle in the produced optical waveguide might become 90% of the weight.
[0146] (Example 3 of reference) Optical waveguide was produced like the example 2 except having blended the titania particle so that the loadings of the particle in the produced optical waveguide might become 2% of the weight.
[0147] (Example 4 of reference) Optical waveguide was produced like the example 2 except having blended the titania particle so that the loadings of the particle in the produced optical waveguide might become 85% of the weight.

[0148] (Example 5 of reference) Optical waveguide was produced like the example 3 except having blended the copper grain child so that the loadings of the particle in the produced optical waveguide might become 8% of the weight.
[0149] (Example 6 of reference) Optical waveguide was produced like the example 3 except having blended the copper grain child so that the loadings of the particle in the produced optical waveguide might become 87% of the weight.
[0150] About the optical waveguide produced in examples 1-9, the example 1 of a comparison, and the examples 1-6 of reference, perform the reliability trial left under 135 degrees C and conditions of 85% of relative humidity for 100 hours, and it sets before and after this reliability trial. When the transmission loss of a lightwave signal with a wavelength of 0.85 micrometers is measured, in the optical waveguide of examples 1-9 In the optical waveguide of the example 1 of a comparison, the rate of increase of transmission loss was 25% or more to the rate of increase of transmission loss having been 15% or less, and the rate of increase of transmission loss was 15 - 20% in the optical waveguide of the examples 1-6 of reference. In addition, the rate of increase of transmission loss was computed from the following formula (1).
[0151]
Rate-of-increase =[(difference of transmission loss before and behind reliability trial)/(transmission loss before reliability trial)] x100 of transmission loss ... (1)
[0152] Moreover, it observed whether exfoliation would have occurred between whether about the optical waveguide produced by the optical waveguide of examples 1-9, before and after the above-mentioned reliability trial, configuration observation was performed and the crack has occurred, a base material, and optical waveguide. Consequently, in the optical waveguide of examples 1-9, neither generating of a crack nor generating of exfoliation between a base material and optical waveguide was observed before and after the reliability trial.
[0153] (Example 10)
A. The production bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section of the resin film for the resin insulating layers between layers, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, Dainippon Ink & Chemicals, Inc. make FENO light KA-7052) 30 weight section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicon system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared. After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating layers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0154] The mean particle diameter by which coating of the silane coupling agent was carried out to the preparation bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section of the resin constituent for through tube restoration and a front face B. By 1.6 micrometers the diameter of grain of maximum size — SiO2 spherical particle (the Adtec Corp. make —) 15 micrometers or less CRS The viscosity prepared the resin filler of 45 - 49 Pa-s at 23**1 degree C by carrying out stirring mixing of the 1101-CE170 weight section and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section for a container. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.
[0155] C. Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.8mm or BT (bismaleimide triazine) resin of a multilayer printed wiring board was used as the start ingredient (refer to drawing 2 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 21 — a conductor — the circuit 24 and the through hole 29 were formed.

[0156] (2) a through hole 29 and a conductor — the conductor which washes in cold water the substrate in which the circuit 24 was formed, carries out software etching after carrying out acid cleaning, and, subsequently to both sides of a substrate, includes the through hole 29 by sending with a conveyance roll after spraying an etching reagent by the spray — the roughening side (not shown) was formed in the front face of a circuit 24. As an etching reagent, it is imidazole copper. The etching reagent (the product made from MEKKU, MEKKU dirty bond) which consists of the (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0157] (3) Next, the optical waveguide 50 which uses the following approaches for the position on a substrate, and has the optical-path conversion mirror 51 was formed (refer to drawing 2 (b)). That is, the tip forms 45-degree optical-path conversion mirror in the end of the optical waveguide produced in the example 1 using the diamond saw which is 90 degrees of V types, and this optical waveguide was stuck so that the side face of that other end by the side of optical conversion mirror agenesis and the side face of a substrate might gather. In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the substrate of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour. In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.
[0158] (4) the following approach after preparing the resin filler indicated to Above B — after preparation — less than 24 hours — the conductor of one side of the inside of a through hole 29, and a substrate 21 — the circuit agenesis section, the optical waveguide agenesis section, and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24 (refer to drawing 2 (c)). That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section (the optical waveguide agenesis section is included) lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes. subsequently, the conductor of the field of another side — the circuit agenesis section (the optical waveguide agenesis section is included) and a conductor — the layer of resin filler 30' was formed like the rim section of a circuit (refer to drawing 2 (c)).
[0159] (5) the belt sander [one side / which finished processing of the above (4) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0160] thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor — the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 2 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.
[0161] (6) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, the land front face of a through hole 29, and a wall — a conductor — the roughening side was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0162] (7) Next, the somewhat larger resin film for the resin insulating layers between layers than the

substrate produced by Above A was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 22 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 2 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.

[0163] (8) Next, mind the mask with which the through tube with a thickness of 1.2mm was formed on the resin insulating layer 22 between layers, and it is CO2 with a wavelength of 10.4 micrometers. By gas laser, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 22 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 3 (a)).

[0164] (9) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers. Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.

[0165] (10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 3 (b)).

[Nonelectrolytic plating water solution]

NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol (PEG) 0.10 g/l [nonelectrolytic plating conditions] It is 40 minutes [0166] by whenever [30-degree C solution temperature]. (11) Next, stick a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, lay a mask, and it is 100 mJ/cm2. The plating resist 23 with a thickness of 20 micrometers was formed by exposing and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 3 (c)).

[0167] (12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 3 (d)).

[Electrolysis plating liquid]

Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO GL)

[Electrolysis plating conditions]

Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0168] (13) — a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under the plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution removal and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation removal of the plating resist 23 by NaOH 5% — the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 4 (a)).

[0169] (14) next, the thing for which the process of above-mentioned (6) - (13) is repeated — the

upper resin insulating layer between layers, and a conductor — laminating formation of the circuit was carried out (refer to drawing 4 (b) - drawing 5 (b)). furthermore, the approach used at the process of the above (6) and the same approach — using — the conductor of the outermost layer — the roughening side (not shown) was formed in the circuit 25 (the Bahia hall 27 is included), and the multilayer-interconnection plate was obtained.
[0170] (15) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation — shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 3.0 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent. In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold). In addition, a commercial solder resist constituent can also be used as the above-mentioned solder resist constituent.
[0171] (16) Next, the above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of a multilayer-interconnection plate the condition for 30 minutes at 70 degrees C, and the layer of a solder resist constituent was formed in them.
[0172] (17) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical paths was drawn was stuck in the layer of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening for solder bump formation of 200 micrometers of diameters of opening, becoming opening, and opening for optical paths of 150 micrometers of diameters of opening and becoming opening were formed. Furthermore, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, the layer of a solder resist constituent is stiffened, it has the opening 39 for solder bump formation, and opening for optical paths, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed. Furthermore, the above-mentioned opening for optical paths and opening which was open for free passage were formed in the resin insulating layer between layers by giving the lasing.
[0173] (18) Next, DESUMIA processing was performed to the wall surface of the opening 38 for optical paths formed in the resin insulating layer between a solder resist layer and layers (refer to drawing 6 (a)). Furthermore, the opening 38 for optical paths was made to fill up with and harden the resin constituent containing acrylic resin, and the resin layer 52 for optical paths was formed.
[0174] (19) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 15 for solder bump formation. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10-1 mol/l), a sodium citrate (1.2x10 to 1 mol/l.), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36 (refer to drawing 6 (b)).
[0175] (20) Next, by printing soldering paste to the opening 15 for solder bump formation formed in the solder resist layer 14, and carrying out a reflow at 200 degrees C, the solder bump 17 was formed in the opening 15 for solder bump formation, and it considered as the multilayer printed wiring board

(refer to drawing 1).
[0176] (Example 11) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 2.
[0177] (Example 12) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 3.
[0178] (Example 13) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 4.
[0179] (Example 14) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 5.
[0180] (Example 15) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 6.
[0181] (Example 16) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 7.
[0182] (Example 17) In the process of (3) of an example 10, it replaced with the optical waveguide produced in the example 1, and the multilayer printed wiring board was manufactured like the example 10 except having used the optical waveguide produced in the example 8.
[0183] (Example 18) In the process of (3) of an example 10, the multilayer printed wiring board was manufactured like the example 10 by passing through the process of following (i) – (iii) except having produced optical waveguide.
(i) The undershirt clad section was formed by carrying out spreading membrane formation of the resin constituent for the clad sections prepared in the example 1 by 50 micrometers in thickness using a spin coater, carrying out temporary hardening of this the condition for 80 degrees C and 20 minutes, carrying out after exposure by 2000mJ, and carrying out heat hardening to the position on a substrate the condition for 60 minutes at 140 degrees C first.
[0184] (ii) Next, by the thickness after hardening carrying out spreading membrane formation of the resin constituent for the core sections prepared in the example 1 by 50 micrometers on the undershirt clad section, carrying out temporary hardening of this the condition for 20 minutes at 80 degrees C, and performing exposure and a development by 500mJ, after setting the width of face to 50 micrometers, heat hardening was carried out the condition for 60 minutes at 150 degrees C, and the core section was formed. In addition, the skin was formed in the front face of the layer after temporary hardening processing.
[0185] (iii) Next, after having carried out spreading membrane formation of the resin constituent for the clad sections so that the thickness on the core section might be set to 50 micrometers, and carrying out temporary hardening of this the condition for 20 minutes at 80 degrees C on the undershirt clad section (a core section top is included), by exposing by 2000mJ and carrying out heat hardening the condition for 60 minutes by 140, the exaggerated clad section was formed and it considered as optical waveguide. In addition, the thickness of the formed optical waveguide was 150 micrometers.
[0186] The following evaluation approach estimated the multilayer printed wiring board obtained in the examples 10-18 by performing configuration observation of (1) optical waveguide, detection of (2) lightwave signals, and (3) continuity checks.
[0187] About the multilayer printed wiring board of the configuration observation examples 10-18 of the evaluation approach (1) optical waveguide, the cutter cut these multilayer printed wiring boards so that it might pass along optical waveguide, and the cross section was observed.
[0188] (2) The substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the side in which the optical waveguide of detection **** of a lightwave signal and the multilayer printed wiring board of examples 10-18 is formed was connected through the solder bump so that it might be arranged in the location where a photo detector and a light emitting device counter opening for optical paths, respectively. Next, after attaching the optical fiber

in the exposure from the multilayer printed wiring board side face of the optical waveguide which counters a light emitting device, attaching a detector in an exposure from the multilayer printed wiring board side face of the optical waveguide which counters a photo detector and making a lightwave signal calculate with delivery and IC chip through an optical fiber, the detector detected the lightwave signal.

[0189] (3) Like detection of the continuity-check above-mentioned lightwave signal, the substrate for IC chip mounting was connected to the multilayer printed wiring board, the continuity check was performed after that, and switch-on was evaluated from the result displayed on a monitor.

[0190] As for the multilayer printed wiring board of examples 10-18, two kinds of optical waveguides, the optical waveguide for light-receiving and the optical waveguide for luminescence, were formed in the position as a result of the above-mentioned evaluation. Moreover, in the multilayer printed wiring board of examples 10-18, the multilayer printed wiring board which connected the substrate for IC chip mounting, could detect the desired lightwave signal when a lightwave signal was transmitted, and was manufactured by this example became clear [having sufficient lightwave signal transmission ability]. Furthermore, in the multilayer printed wiring board of examples 10-18, in the continuity check at the time of connecting the substrate for IC chip mounting through a solder bump, it was satisfactory to the conductivity of an electrical signal, and it became clear that an electrical signal can also be transmitted with a lightwave signal.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since the resin constituent for optical waveguides of this invention consists of a configuration mentioned above, when forming optical waveguide on a base material etc. using this resin constituent for optical waveguides The optical waveguide which consists of the above-mentioned resin constituent for optical waveguides which hardly generated the crack and exfoliation resulting from the difference of a coefficient of thermal expansion, and was formed on the base material etc. Since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity when the heat history is received, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses, and a lightwave signal can be transmitted good.
[0192] Since the optical waveguide of this invention consists of a configuration mentioned above, when formed on the base material etc., this optical waveguide The above-mentioned optical waveguide which hardly generated the crack and exfoliation resulting from the difference of a coefficient of thermal expansion, and was formed on the base material etc. Since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are abbreviation homogeneity when the heat history is received, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses, and a lightwave signal can be transmitted good.

[0193] Since the multilayer printed wiring board of this invention consists of a configuration mentioned above, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, and a substrate and the resin insulating layer between layers. The crack and exfoliation resulting from the difference of a coefficient of thermal expansion are hardly generated. Moreover, the above-mentioned optical waveguide Since the expansion coefficient of the X-axis / Y shaft orientations and the expansion coefficient of Z shaft orientations are at abbreviation homogeneity even if it receives the heat history, the balance in the TM0 mode of optical waveguide and the TE0 mode hardly collapses, and a lightwave signal can be transmitted good. moreover, the above-mentioned multilayer printed wiring board — a conductor — since optical waveguide is built in in the multilayer printed wiring board while being able to transmit both a lightwave signal and an electrical signal, since a circuit and optical waveguide are formed, it can contribute to the miniaturization of the terminal equipment for optical communication.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the multilayer printed wiring board of this invention.
[Drawing 2] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of this invention.
[Drawing 3] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of this invention.
[Description of Notations]
100 Multilayer Printed Wiring Board
21,121 Substrate
22,122 Resin insulating layer between layers
24,124 a conductor — circuit
25,125 a conductor — circuit
27,127 Bahia hall
29,129 Through hole
38,138 Opening for optical paths
34,134 Solder resist layer
36,136 Solder pad
37,137 Solder bump
50,150 Optical waveguide

[Translation done.]